What You Need to Know When Upgrading Power Transformers on Campus

If your transformers are 10-15 years old, now is the time to take proactive steps to save utility costs and prevent power outages.

On May 2, 2013, a transformer explosion caused a power outage and forced evacuations at the University of La Verne in California. The local police department closed off adjacent areas while the city fire department put out the blaze.

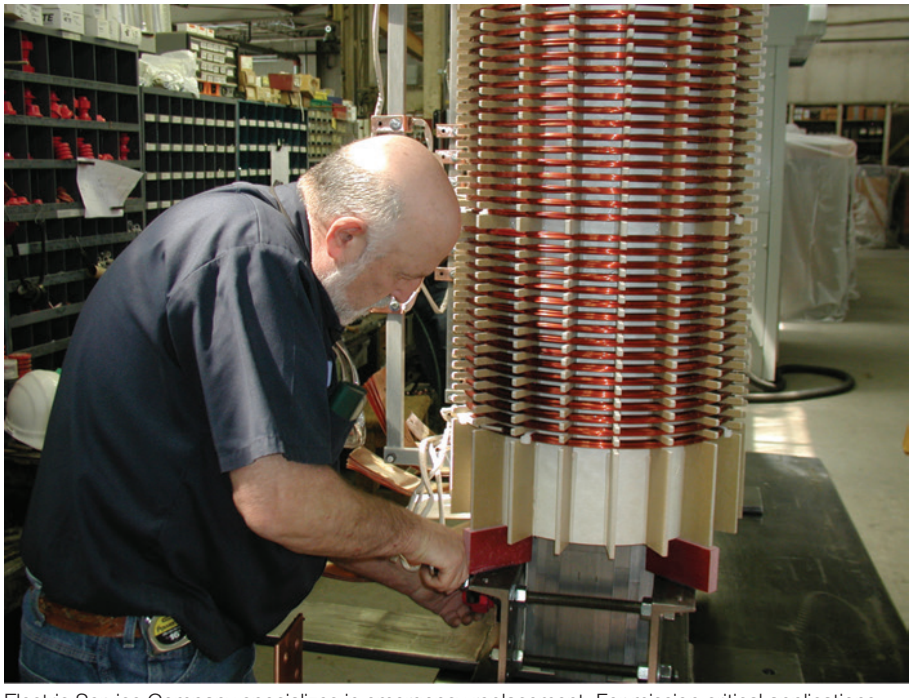
Power transformers seldom go down, but when they do the effects on campus operations are immediate and devastating. Beyond the lost continuity of classroom instruction, the risk of subsequent fires, fines, security lapses and lawsuits can quadruple the damages.

At the same time, legacy power transformers represent a huge money drain on an educational institution's operating budget when they force the campus to pay a steeper price for stepped-down electricity. With the current move by utility companies to deliver higher and higher voltages from the grid, many schools, colleges and universities must replace their transformers.

"We were looking at a multi-phase process to literally transform our entire campus from a 5KV to 15KV distribution system because our utility company would no longer supply the lower voltage," says Ben Johnson P.E., Assistant Director of Planning, Design, and Construction at Western Kentucky University at the Bowling Green location. "Between that and the occasional failures within our system, not doing anything was no longer an option."

Spurring the need for replacement is the aging infrastructure at many established teaching institutions.

"The units in our substation were 40-60 years old, and were operating at 120-125% of capacity," continues Johnson. "Since the utility said they would no longer provide 5KV class service we had to change every primary transformer on campus."



Electric Service Company specializes in emergency replacement. For mission critical applications, transformers can be prepped for shipping within a matter of hours. But to ensure a rapid return to operation, any replacement transformer must duplicate "form, fit and function" as much as possible.

According to "An Analysis of Transformer Failures" by William H. Bartley, P.E., on behalf of the Hartford Steam Boiler Inspection and Insurance Company, the average age at the time of failure ranged from only 9.4 to 14.9 years.

"Our 4160 volt system was in rough enough shape and fragile enough that it was not uncommon for us to have 3-6 major outages per year," Johnson adds. "That is obviously not acceptable. Those problems extend your downtime, and when you're in an academic setting, that's a killer."

Identifying a Robust Transformer

Faced with massive upgrades, whether demanded by an electricity provider or for preventative purposes, many campus facility engineers are now beginning the process of acquiring newer power transformers. For public entities, the project must be put out to bid. But in writing the RFQ specifications for any campus distribution system, engineers can ensure that they obtain an asset that will provide cost-effective and long-lived service through a basic knowledge of the design, construction and materials of power transformers.

Starting from the top, common types of power transformers found on campuses include liquid-filled (so called because they use oil, or similar, for cooling purposes), and dry- type transformers. Given that dry-types are air-cooled, they pose less chance of leakage and fire risk.

"Whether wet or dry-type, the way the coils are wound around the core of the transformer greatly affects its robustness," says Alan Ober, Vice President of Engineering and Manufacturing Continued on page 16

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for Electric Service Company (ELSCO). Founded in 1912 by former Westinghouse engineers, ELSCO specializes in providing quality new, repaired and rebuilt transformers—under emergency conditions when necessary—from their Cincinnati, Ohio manufacturing plant.

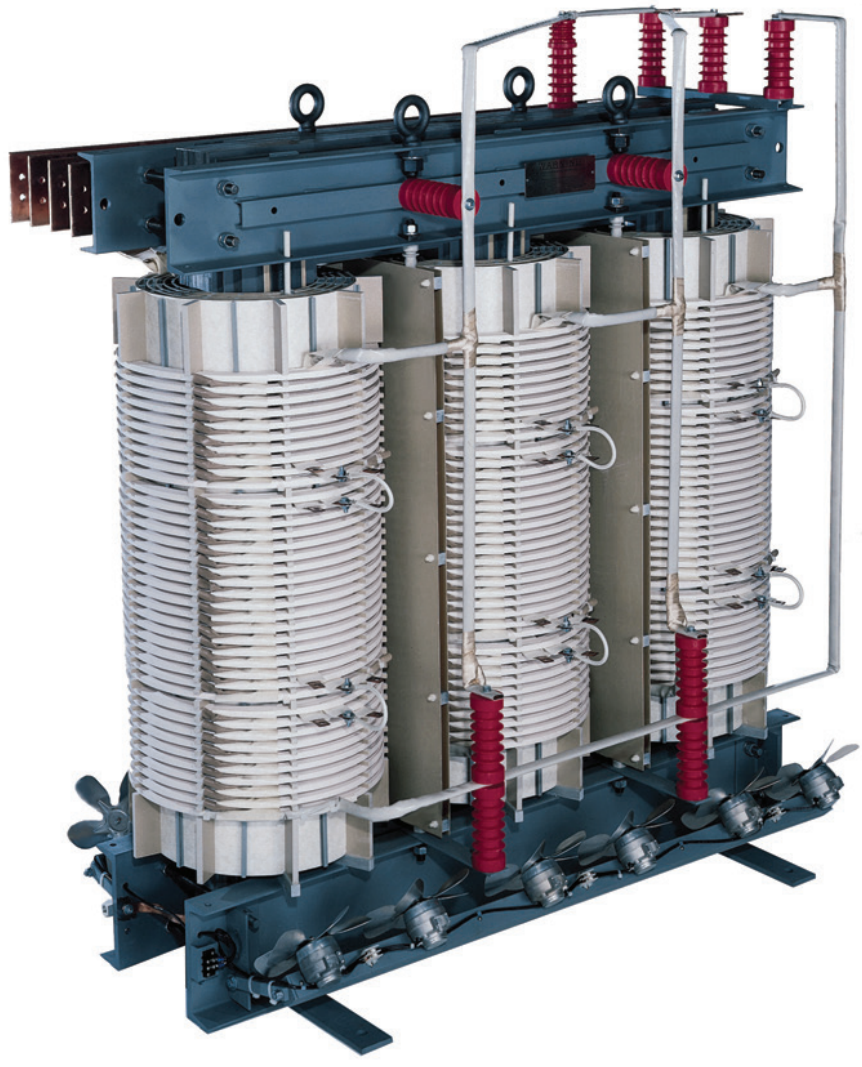
"Because of increased axial forces acting at the corners of rectangular-wound transformers, energy gets wasted and noise is created," continues Ober. "On the other hand, voltage stresses are halved between the discs of round-wound designs. Hence, round disc-wound transformers stay cooler, run quieter, present less risk of short circuit and are more energy efficient."

"Beyond the improved reliability factor, the increased efficiency of the round design saves costs in real time, as the plant consumes less electricity. Some round disc-wound transformers even exceed the proposed efficiency standards for Energy Star compliance, drastically lowering utility costs for a plant", according to Ober.

When it comes to the material used for the windings, copper is a superior conductor to aluminum because copper offers less resistance, hence less heat. Additionally, aluminum corrodes which generates heat and reduces lifespan while posing a fire hazard.

"If aluminum shows up in transformers at all, it's because copper currently sells for about $6,500 per ton, whereas aluminum costs around $1,700 per ton," notes Ober. "Yet, any savings gain here evaporates under operating considerations."

Even insulation plays a major part in ensuring reliability. Temperatures can reach 200 degrees C in a dry transformer on a daily basis; hence, skimping on insulation can lead to disastrous consequences. Glastic fiberglass insulation or Nomex® provide significantly greater protection from fires and short circuits than paper insulation. Note that Nomex® is used in racing suits for Formula 1 drivers to protect them from burns.



Transformers seldom fo down, but when they do the effects to the bottom line are immediate and devasting. Utilizing a two-pronged approach, though, facility managers can stack the odds in their favor and prevent the loss of hundreds of thousands of dollars.

Saving Money by Remanufacturing

Similar considerations apply when purchasing a reconditioned transformer as for a new one; except that the expertise of the remanufacturer plays a greater role.

"At the bottom end of the remanufacturing scale are transformers that are brought in, fixed up just enough to be operational, superficially cleaned and then sent out the door," notes Ober. "These won't hold up as well as transformers that are completely refurbished, and could leave your plant vulnerable once again."

A more completely remanufactured transformer provides far greater security against failures. There should be a complete rewinding of the primary and secondary coils along with brand new high and low voltage bus bars. While the original core can be kept 90% of the time, even it must be replaced occasionally as older steel is less energy efficient than modern core materials.

Attention to detail pays dividends in the remanufacturing process. Hand wiring ensures the highest quality. Additionally, the deburring of the copper conductor helps ensure that the insulation won't be punctured and create a short circuit.

Ultimately, any remanufactured transformer must meet or exceed all NEMA, ANSI and IEEE standards.

Matching the Old with New

Too often relegated to last-minute consideration is the need to ensure that any new power transformer fits into existing campus switchgear—carefully duplicating "form, fit and function" as much as possible.

"The main problem I've seen with some installations is adapting to existing facilities; it may seem like a small thing but it's really huge," cautions Johnson. "Obviously there will be mating and connectivity issues between your substation transformer and the secondary switchgear. I've seen cases with mass-produced Continued on page 18

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transformers where at the end of the day you have to kluge it together to make it work. Sometimes it turns into a 'beat to fit, paint to match' sort of thing."

"Our old on-campus equipment dated anywhere from the late 1920s to the 1980s," continues Johnson. "This is where a custom-designed transformer and bus bar, like we get with the ELSCO transformers, really shines. The known reliability and track record of their transformers played a part in my selection of ELSCO. I'm an EE by trade and have been involved in electrical construction for over 25 years, so I have a respect for hardware."

When Emergencies Do Happen

For those learning institutions that can't replace their out-dated transformers fast enough, accidents will happen, as when a blown transformer caused a power outage at Del Mar College in Corpus Christi, Texas two years ago, immediately halting classes.

To rapidly stem such losses, transformer companies exist that specialize in emergency replacement. For mission critical applications, such as on-campus medical clinics, transformers can be prepped for shipping within a matter of hours. Attention to details such as duplication of the high and low voltage bus bar spells the difference between a lengthy replacement process versus a quick, cost-effective plug-and-play solution that brings the campus back online in minimal time.

"Even though we are a public institution and must put everything out to bid, we are permitted to buy from a sole source to alleviate the emergency," says Johnson. "Few would argue against a power outage as being an emergency."

Going Forward

As more campuses like WKU—with approximately five million square feet under roof—must switch out dozens of distribution transformers, cables and underground vaults, the process will not take place overnight. Johnson recommends tackling the oldest transformers first.

"Of the 58 buildings we have on campus, I've still got about 18 to go so we're still working it," adds Johnson. "We replaced our worst equipment first to get them offline before we had more failures. Since we've had two-thirds of our system already replaced, obviously our failure rate has gone way down. We've never had any issues out of anything we've ever put in."

"For other engineers in the same situation as I'm in here at WKU, I would absolutely recommend replacing your old transformers at your university," continues Johnson. "Especially when you're dealing with public funding scenarios like we are." ❑

For more information, contact: Electric Service Company (ELSCO); 5331 Hetzel Street, Cincinnati; OH 45227; 800-232-9002 or 513-271-1752; FAX: 513-271-0543; info@electricservice.com or www.electricservice.com.